# From HIS to IAIMS: Expanding the Scope of Information Processing Applications in a German University Hospital

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*Since the mid eighties the department of medical informatics at the University Hospital of Gießen (Germany) has been engaged in the development of a comprehensive hospital information system. The installation of a campus wide network has set the basis to provide not only clinical patient-oriented information, but also general information resources for research, medical education and administrative purposes, thus creating an environment which in the U.S. became known as an integrated academic information management system (IAIMS). The underlying concept of the whole approach is to provide one-stop information shopping capabilities at the clinicians and administrators desktop in order to meet the increasing information needs of health professionals with the emerging reality of the potential benefits of computer and communication technologies. This paper describes the various steps performed to realize this concept at Gießen University Hospital and the evaluation results derived from analysis of the acceptance of these new technologies among our hospital staff.*

## INTRODUCTION

Gießen University Hospital is a 1,350 bed hospital which has about 36,000 inpatient admits and 320,000 outpatient visits per year. There are 4,000 employees and staff. During the last two years the HIS at Gießen University Hospital (WING [1]) has emerged from the phase of prototype and pilot implementations towards the state of a routinely used system with comprehensive coverage of inpatient departments and outpatient clinics. In the same time, the scope of information processing applications which were accessible for clinical and academic users was continuously expanded. These efforts have led to a set of information resources, covering clinical and administrative patient data, various clinical and administrative information services and a number of medical education programs. Even though in Germany an official analogue to the U.S. IAIMS grant program does not exist, this integrated institutional approach for the implementation of an information management system for clinical practice, medical education and biomedical research has constituted an IAIMS-like system (according to the terminology of Lindberg et al.[2]).

## THE WING/GISNET STATUS

The design, development and implementation of the HIS at Gießen University Hospital can be divided into four phases. These are (1) the phase of isolated departmental systems (1975-1985), (2) the HELP evaluation phase (1986, 1987), (3) the prototyping phase (1988-1991) and (4) the production phase (since 1992). Even though, we appreciated the general concept (e.g. a central medical data dictionary and integrated decision support functions) of the HELP system very much, organizational differences between German and American Hospitals (and accordingly the requirements for HIS functionalities) proved to be too large, so that we finally discarded the idea of adapting this American HIS to our hospital environment. The decision was made to start with own HIS developments, keeping in mind all our HELP experiences and the basic ideas and concepts of the HELP system (for more details compare [1]). This new HIS development approach was named WING (which is the abbreviation of the German terms for 'knowledge based information network in Gießen'). While, during the prototyping phase, the first WING functions could only be tested in three nursing units, the opening of a new premise for the surgery department (fully connected to the backbone network (GISNET)) and the extension of the network in the internal medicine department in 1992, initiated a widespread HIS usage throughout the whole hospital campus. Today (August 1994) about 500 clinical workstations in more than 100 different nursing units and various laboratories and outpatient clinics are connected to the network and are accessed by more than 1000 clinical users.

The network (GISNET) is geographically distributed across an area of about 2 square kilometers with 25 different medical and administrative buildings. It encompasses 2 Tandem mainframe computers, a Tandem Unix server, a HP 9000, two AEG Modcomp computers, about 20 SUN workstations and servers, 15 Novell file servers, a CD-ROM server, about 350 DOS PCs, the same number of printers and a growing

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number of Macintosh computers. The network is based on ethernet with a backbone moving to ATM within the next years. It supports TCP/IP, IPX, Netbios and DEC-LAT-protocol.

## ONE-STOP INFORMATION SHOPPING

While expanding the information processing capabilities throughout the Gießen University Hospital during the last two years, we were pursuing the goal, to implement the concept of "one-stop information shopping" (as described for example by Clayton et al. [3]). This means that EDP workstations (discless DOS PCs) with an attached printer are available at all nursing stations and physician offices as well as numerous laboratories, outpatient clinics and secretary offices. Thus, the hospital staff has access to various information resources from their desktop through the GISNET main menu and 4 sub-menus. The available information resources comprise (1) clinical patient data (e.g. laboratory data, diagnosis and physician discharge summaries as well as specialty specific medical documentation of oncology and cardiology data), (2) administrative patient data, (3) medical and administrative information services (e.g. the drug information system edited by the German pharmaceutical industry (Red List), the Micromedex information systems (DRUGDEX, POISINDEX, MARTINDALE, TOMES), a medical terminology dictionary, a diagnostic consultation system and the German train schedule), (4) library services (MEDLINE), (5) medical education programs (e.g. cardiac emergency case simulations, physiology question catalog) and (6) standard Novell/ DOS software (e.g. MS-Word, Harvard-Graphics, Microsoft Windows, Excel, electronic mail).

## GISNET INFORMATION RESOURCES

The functionality of the clinical information system WING and some of the integrated clinical subsystems has been extensively described elsewhere (e.g. [1, 4, 5, 6]). In the following we will present our approach to make non-patient-related information accessible for clinical care, biomedical research and medical education.

### Medical Information Services

Drug information is usually the most often required information to support the physician in defining his/her therapeutic strategy. Traditionally, the German pharmaceutical industry yearly publishes a book with drug information for all the brands currently available at the German market and provides this book to every German physician. Because of its red cover this book is called the "Rote Liste" (Red List). Lately the information provided within the book is additionally available within a PC-based drug information system. The information contents is updated every six month. The network version of the Red List has been installed on a GISNET Novell fileserver in spring 1992 and is available at every connected workstation. For a more comprehensive and scientific coverage of drug information the pharmacy of Gießen University Hospital has decided to provide access to the DRUGDEX database from Micromedex additionally to the Red List. DRUGDEX together with POISINDEX, MARTINDALE, REPRORISK and DRUG-INTERACTIONS are stored on one CD-ROM and supplied with a common user interface.

### Library Services

Another goal of our developments was to provide a system for quick and easy access to bibliographic references of the medical literature. We therefore connected a CD-ROM server to the network with 14 CD-ROM players attached to it. Using the Silverplatter software package we thus provide access to medical literature references from 1966 up to now stored within the MEDLINE database. Retrieval results may be downloaded on the user's privat file server directory or printed on a freely selectable GISNET printer. A customized program supports the automatic generation of the official library ordering form for books or journal articles.

### Hospital Internal Information Services

In 1994 the clinical users asked us to additionally provide some means for hospital internal information services. In regard to this, a first step was done by installing an online version of the hospital's weekly updated cafeteria menu plan. Until today the hospital kitchen regularly distributes a paper-based plan in hundreds of copies throughout the whole hospital. In all locations connected to GISNET this plan can now directly be reviewed (and printed) from the staff's desktop workstation, thus eliminating the need for a paper-based distribution.

After this successfull first implementation it was decided to develop a generic framework for the creation, maintenance and access to hospital internal "electronic books". This framework comprises an editor module (to define the book's structure and search index), a reader module (to access an electronic book from the GISNET workstations), a bulletin board module (which serves as a communication function between the readers and the editor of a book) and an analysis module (to derive various statistics on the usage of an electronic book).

The first book created with these tools and integrated into the GISNET environment is related to WING/GISNET itself. It shall provide an easy way to inform the hospital staff on activities associated with information processing developments, program updates and new installations, user instructions as well as seminars and other courses, thus serving as an IAIMS newsletter within the Gießen University Hospital. Furthermore, three more electronic books are under development by clinical departments, focusing on "infectious disease information", "adverse drug events" documented at our hospital and the pharmacy's "drug formulary".

**Medical Education Programs**

During 1993 a close cooperation between the department of medical informatics and the medical faculty was established in order to analyse and propose a new and innovative structure for the medical curriculum applying modern hard- and software technologies. In this cooperation different scenarios for the integration of medical education programs into the medical curriculum have been evaluated. A proposal for a long term strategy is currently under development. In the meantime several small steps have already been accomplished to investigate the attitude of students but also teachers on the usage of new electronic media and to provide campus wide access to a preliminary set of medical education programs throughout the GISNET interface. Thus, since July 1993 three case simulation programs for cardiac emergency situations have been implemented on a Novell file server and made accessible within a GISNET submenu. After first positive responses to the installation of these programs three more programs (case simulations on reanimation and abdominal pain as well as a physiology questions catalog) were added in February 1994.

To perform a formal evaluation of the usage of these programs and the users attitudes towards such medical education programs a short electronic questionnaire was developed. Thirteen questions were asked in order to determine the user's background, general attitude towards computers and computer usage in medicine, the duration of the current session, a rating for the program he/she has just used and if he/she would recommend the program to colleagues and wishes to have more computer-based medical education programs accessible at the GISNET workstation. During February and March 1994 this questionnaire was automatically presented to every user of any of the six programs.

**Administrative Information Services**

As an information service mainly focused on secretaries and administrative staff the complete German train schedule and the German postal code reference system have been implemented in summer 1993. The latter was especially helpful in the second half of 1993 since in July 1993 the German postal code system has been completely revised and changed from a four-digit to a five-digit system.

## RESULTS

Different approaches have been choosen to evaluate the various steps performed in broadening the scope of information services at Gießen University Hospital. First of all, an internal logging mechanism keeps track of every usage of any of the newly established services. Secondly, a paper-based questionnaire has been sent to all physicians of the two departments which have had the longest experience with the WING/GISNET functionalities, trying to investigate the attitude of the clinical users to electronic data processing in general, but also specificly to the services provided to them through the GISNET workstations. Finally, the attitude to the six medical education programs was investigated by the means of an electronic questionnaire which was appended to each of the implemented education programs during the months of February and March 1994.

**The GISNET Logfile**

The following presents the analysis results for the logfile entries during the first quarter of 1994. Among the newly established GISNET services MEDLINE is the most widely used (47 calls per day). Second in usage is the German drug information system (37 calls per day). The cafeteria menu is reviewed 26 times per day and train schedules are retrieved 18 times per day. The medical dictionary, the medical diagnostic consultation system, the postal code reference system and the American drug information system DRUGDEX are less often accessed (with 11, 9, 7 and 4 calls per day).

In total an average of 159 daily calls to any of the above mentioned information services have been logged during the first three months of 1994 and the medical education programs have been used in average 38 times per day. Among these programs one (the cardiac emergency case simulation program) seems to be more attractive (with about 10 daily calls), whereas the other five are about equally often used (five to six calls per day).

**The WING/GISNET Questionnaire**

One section of the questionnaire send to the physicians of two major departments at Gießen University Hospital was related to the physician's frequency of use and their rating of the available information sources. Analysis of the responses confirmed the results from the logfile analysis. On a scale between 0 and 5 (where 5 denotes "very helpful") MEDLINE and the German drug information system Red List received average ratings of 4.38 and 4.35 respectively (the second best ratings after the WING module for laboratory results review) and were the most often used GISNET resources. 43% of the physicians reported that they access the Red List at least once a day, whereas the majority of the physicians (38%) retrieve bibliographic information from MEDLINE several times a week (14% reported accessing it once or more times per day). The requests for additional information sources given as responses to this questionnaire have stimulated the implementation of some of the newer GISNET resources (e.g. the medical dictionary and the diagnostic consultation system).

**The Medical Education Programs Questionnaire**

Even though the GISNET workstations are generally not accessible for medical students (since they are usually installed in clinical environments and not in any location open to students) the medical information programs installed on a GISNET file server were positively received among the GISNET users. During the two months period of formal evaluation with the electronic questionnaire we received a total of 1315 responses. One surprising result was that nursing staff were the favorite users of these programs (39% of all calls), followed by medical students (25%), physicians (19%) and others (17%).

Further analysis showed that 11% of the users have used a program more than 5 times, 20% have used it between 2 and five times and 69% have used it for the first time. In 83% of all uses a single user was working with the corresponding program whereas in 17% of the calls the program was used by a group of users. In most cases (51% of all calls) the program was only used for a time period of less than 15 minutes (which may just be sufficient to work through one case simulation). Nevertheless, 37% reported a working time between 15 minutes and 1 hour and 12% of even more than an hour. In 62% of the calls the users reported that they had fully completed a session, whereas in 38% they had quit the program without finishing a simulation case (however, no reason for this was specified).

In order to get a rating for the six programs the questionnaire distinguished between the overall quality of a program, the users benefit from using the program and the ease of handling. On a scale between 1 and 6 (where 1 is the best rating) the programs received average ratings for the overall quality ranging between 2,1 and 3,6. The average ratings for the user's benefit ranged from 2,4 to 2,9 and finally the ratings for the ease of handling ranged from 2,6 to 3,4. Finally, 68% of the users reported that they would recommend the corresponding program to other GISNET users and 78% of them requested that further medical education programs should be implemented within GISNET.

## DISCUSSION

The evaluation analysis has shown that there exists a broad spectrum of information needs amongst health professionals which is not only limited to patient related data. The information services provided within the GISNET environment have been widely accepted throughout the hospital staff. We even got the impression, that next to the laboratory results review module, these services helped some people to reduce eventually existing acceptance barriers and attracted them to integrate a computer workstation as a natural tool within their daily work environment.

Networking was the fundamental supposition for this movement towards an IAIMS-like environment. It offered the technical platform which was necessary to integrate a variety of different information sources. In future a vast number of both local and national computer-based information resources will be accessible and may be integrated in the environment of clinical or academic workstations with relatively small technical efforts and low costs. However, this does not mean, that all problems in information management are already solved. Our investigations have also revealed several challenges for further improving the IAIMS environment.

First of all, even though more than ten information resources can currently be directly accessed from the clinicians desktop, together replacing an enormous amount of traditional paper-based information sources (e.g. books) from which some were not even available anywhere in the hospital in former times, clinicians already claimed that finding the relevant piece of information sometimes takes minutes and may be cumbersome, since switching back and forth between different information resources is time consuming and requires formulating similar search commands multiple times in different environments.

Solutions to this problem may be given with different levels of comfort for the information retriever. A first short term approach is, to substitute the current DOS-based GISNET menu environment by a WINDOWS-based environment supporting the simultaneous opening of multiple information sources in different windows of the screen (thus eliminating the need to go back and forth through different menu screens and wait during the processes' startup time). However, this might not only bring improvements, since the WINDOWS-environment will also increase the complexity of the user interface and may confuse some of the novice users. The implementation of a drug therapy documentation module [4] has already discovered problems with windows hidden behind each other, adaption to using the mouse or even space problems for the mouse on a desktop already covered with numerous forms and patient charts. Nevertheless, the advantages and the problems related to such a new GISNET user interface will be investigated this summer during a pilot installation on two nursing stations of our hospital.

A second long term strategy is to integrate relevant information sources directly into the environment of clinical HIS applications and render context-sensitiv information access without the need (for the user) to know from which information resource such information may actually be derived from. However, this is a highly complex endeavour which first needs to tackle the questions of "which information is relevant in which clinical context?" (compare e.g. [7]) and "how can the local terminology be mapped to the vocabularies of external information resources?". Research results of the UMLS (Unified Medical Language System) project [8] hopefully may provide answers at least to the latter question in the near future.

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